APPENDIX A

Subnetting Practice: 25 Subnetting Questions

This appendix lists 25 separate questions, asking you to derive the subnet number, broadcast address, and range of valid IP addresses. In the solutions, the binary math is shown, as is the process that avoids binary math using the "subnet chart" described in Chapter 4, "IP Addressing and Subnetting." You might want to review Chapter 4's section on IP addressing before trying to answer these questions.

25 Subnetting Questions

Given each IP address and mask, supply the following information for each of these 25 examples:

- Size of the network part of the address
- Size of the subnet part of the address
- Size of the host part of the address
- The number of hosts per subnet
- The number of subnets in this network
- The subnet number
- The broadcast address
- The range of valid IP addresses in this network:

1. 10.180.10.18, mask 255.192.0.0
2. 10.200.10.18, mask 255.224.0.0
3. 10.100.18.18, mask 255.240.0.0
4. 10.100.18.18, mask 255.248.0.0
5. 10.150.200.200, mask 255.252.0.0
6. 10.150.200.200, mask 255.254.0.0
7. 10.220.100.18, mask 255.255.0.0
8. 10.220.100.18, mask 255.255.128.0
9. 172.31.100.100, mask 255.255.192.0

10. 172.31.100.100, mask 255.255.224.0
11. 172.31.200.10, mask 255.255.240.0
12. 172.31.200.10, mask 255.255.248.0
13. 172.31.50.50, mask 255.255.252.0
14. 172.31.50.50, mask 255.255.254.0
15. 172.31.140.14, mask 255.255.255.0
16. 172.31.140.14, mask 255.255.255.128
17. 192.168.15.150, mask 255.255.255.192
18. 192.168.15.150, mask 255.255.255.224
19. 192.168.100.100, mask 255.255.255.240
20. 192.168.100.100, mask 255.255.255.248
21. 192.168.15.230, mask 255.255.255.252
22. 10.1.1.1, mask 255.248.0.0
23. 172.16.1.200, mask 255.255.240.0
24. 172.16.0.200, mask 255.255.255.192
25. 10.1.1.1, mask 255.0.0.0

Suggestions on How to Attack the Problem

If you are ready to go ahead and start answering the questions, go ahead! If you want more explanation of how to attack such questions, refer back to the section on IP subnetting in Chapter 4. However, if you have already read Chapter 4, a reminder of the steps in the process to answer these questions, with a little binary math, is repeated here:

Step 1 Identify the structure of the IP address.

a. Identify the size of the network part of the address, based on Class A, B, and C rules.
b. Identify the size of the host part of the address, based on the number of binary 0s in the mask. If the mask is "tricky," use the chart of typical mask values to convert the mask to binary more quickly.
c. The size of the subnet part is what's "left over"; mathematically, it is 32 – (network + host)
d. Declare the number of subnets, which is $2^{\text{number-of-subnet-bits}} - 2$.
e. Declare the number of hosts per subnet, which is $2^{\text{number-of-host-bits}} - 2$

Step 2 Create the subnet chart that will be used in steps 3 and 4.

a. Create a generic subnet chart.

b. Write down the decimal IP address and subnet mask in the first two rows of the chart.

c. If an easy mask is used, draw a vertical line between the 255s and the 0s in the mask, from top to bottom of the chart. If a hard mask is used, draw a box around the interesting octet.

d. Copy the address octets to the left of the line or the box into the final four rows of the chart.

Step 3 Derive the subnet number and the first valid IP address.

a. On the line on the chart where you are writing down the subnet number, write down 0s in the octets to the right of the line or the box.

b. If the mask is difficult, so that there is a box in the chart, use the magic number trick to find the decimal value of the subnet's interesting octet, and write it down. Remember, the magic number is found by subtracting the interesting (non-0 or 255) mask value from 256. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

c. To derive the first valid IP address, copy the first three octets of the subnet number, and add 1 to the fourth octet of the subnet number.

Step 4 Derive the broadcast address and the last valid IP address for this subnet.

a. Write down 255s in the broadcast address octets to the right of the line or the box.

b. If the mask is difficult, so that there is a box in the chart, use the magic number trick to find the value of the broadcast address's interesting octet. In this case, you add the subnet number's interesting octet value to the magic number, and subtract 1.

c. To derive the last valid IP address, copy the first three octets of the broadcast address and subtract 1 from the fourth octet of the broadcast address.

Question 1: Answer

The answers begin with the analysis of the three parts of the address, the number of hosts per subnet, and the number of subnets of this network using the stated mask. The binary math for subnet and broadcast address calculation follows. The answer finishes with the easier mental calculations using the subnet chart described in Chapter 4.

Table A-1 *Question 1: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Item	Example	Rules to Remember
Address	10.180.10.18	N/A
Mask	255.192.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	22	Always defined as number of binary 0s in mask
Number of subnet bits	2	32 – (network size + host size)
Number of subnets	$2^2 - 2 = 2$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{22} - 2 = 4{,}194{,}302$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-2. To calculate the two numbers, perform a Boolean AND on the address and mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-2 *Question 1: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.180.10.18	0000 1010 10**11 0100 0000 1010 0001 0010**
Mask	255.192.0.0	1111 1111 11**00 0000 0000 0000 0000 0000**
AND result (subnet number)	10.128.0.0	0000 1010 10**00 0000 0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.191.255.255	0000 1010 10**11 1111 1111 1111 1111 1111**

To get the first valid IP address, just add 1 to the subnet number; to get the last valid IP address, just subtract 1 from the broadcast address. In this case:

10.128.0.1 through 10.191.255.254

10.128.0.0 + 1= 10.128.0.1

10.191.255.255 – 1= 10.191.255.254

Steps 2, 3, and 4 in the process use a table like Table A-3, which lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Figure A-1 at the end of this problem shows the fields in Table A-3 that are filled in at each step in the process. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-3 *Question 1: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4	Comments
Address	10	180	10	18	N/A
Mask	255	192	0	0	N/A
Subnet number	10	128	0	0	Magic number = 256 – 192 = 64
First address	10	128	0	1	Add 1 to last octet of subnet
Broadcast	10	191	255	255	128 + 64 – 1 = 191
Last address	10	191	255	254	Subtract 1 from last octet

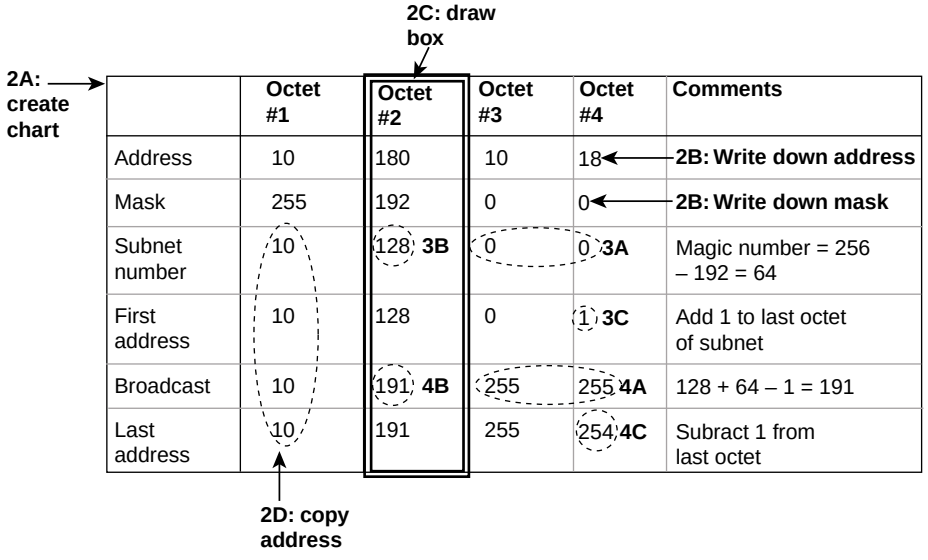
Subnet rule: Multiple of magic number closest to, but not more than, IP address value in interesting octet
Broadcast rule: Subnet + magic – 1

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The second octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 192 = 64 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 128 is the multiple of 64 that's closest to 180 but not bigger than 180. So, the second octet of the subnet number is 128.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 128 + 64 – 1 = 191.

Finally, Figure A-1 shows Table A-3 with comments about when each part of the table was filled in, based on the steps in the process at the beginning of the chapter.

Figure A-1 *Steps 2, 3, and 4 for Question 1*



	Octet #1	Octet #2	Octet #3	Octet #4	Comments
Address	10	180	10	18 ←	**2B: Write down address**
Mask	255	192	0	0 ←	**2B: Write down mask**
Subnet number	10	128 **3B**	0	0 **3A**	Magic number = 256 – 192 = 64
First address	10	128	0	1 **3C**	Add 1 to last octet of subnet
Broadcast	10	191 **4B**	255	255 **4A**	128 + 64 – 1 = 191
Last address	10	191	255	254 **4C**	Subract 1 from last octet

Question 2: Answer

Table A-4 *Question 2: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.200.10.18	N/A
Mask	255.224.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	21	Always defined as number of binary 0s in mask
Number of subnet bits	3	32 – (network size + host size)
Number of subnets	$2^3 - 2 = 6$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{21} - 2 =$ 2,097,150	$2^{\text{number-of-host-bits}} - 2$

Table A-5 presents the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-5 *Question 2: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.200.10.18	0000 1010 110**0 1000 0000 1010 0001 0010**
Mask	255.224.0.0	1111 1111 111**0 0000 0000 0000 0000 0000**
AND result (subnet number)	10.192.0.0	0000 1010 110**0 0000 0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.223.255.255	0000 1010 110**1 1111 1111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.192.0.1 through 10.223.255.254

Table A-6 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-6 *Question 2: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4	Comments
Address	10	200	10	18	N/A
Mask	255	224	0	0	N/A
Subnet number	10	192	0	0	Magic number = 256 – 224 = 32
First address	10	192	0	1	Add 1 to last octet of subnet
Broadcast	10	223	255	255	192 + 32 – 1 = 223
Last address	10	223	255	254	Subtract 1 from last octet

Subnet rule: Multiple of magic number closest to, but not more than, IP address value in interesting octet
Broadcast rule: Subnet + magic – 1

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The second octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 224 = 32 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP

address's value in the interesting octet. In this case, 192 is the multiple of 32 that's closest to 200 but not bigger than 200. So, the second octet of the subnet number is 192.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 192 + 32 – 1 = 223.

Question 3: Answer

Table A-7 *Question 3: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.100.18.18	N/A
Mask	255.240.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	20	Always defined as number of binary 0s in mask
Number of subnet bits	4	32 – (network size + host size)
Number of subnets	$2^4 - 2 = 14$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{20} - 2 = 1{,}048{,}574$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-8. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-8 *Question 3: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.100.18.18	0000 1010 0110 **0100 0001 00100001 0010**
Mask	255.240.0.0	1111 1111 1111 **0000 0000 0000 0000 0000**
AND result (subnet number)	10.96.0.0	0000 1010 0110 **0000 0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.111.255.255	0000 1010 0110 **1111 1111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.96.0.1 through 10.111.255.254

Table A-9 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-9 *Question 3: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4	Comments
Address	10	100	18	18	N/A
Mask	255	240	0	0	N/A
Subnet number	10	96	0	0	Magic number = 256 – 240 = 16
First address	10	96	0	1	Add 1 to last octet of subnet
Broadcast	10	111	255	255	96 + 16 – 1 = 111
Last address	10	111	255	254	Subtract 1 from last octet

Subnet rule: Multiple of magic number closest to, but not more than, IP address value in interesting octet
Broadcast rule: Subnet + magic – 1

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The second octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 240 = 16 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 96 is the multiple of 16 that's closest to 100 but not bigger than 100. So, the second octet of the subnet number is 96.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 96 + 16 – 1 = 111.

Question 4: Answer

Table A-10 *Question 4: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.100.18.18	N/A
Mask	255.248.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	19	Always defined as number of binary 0s in mask
Number of subnet bits	5	32 – (network size + host size)
Number of subnets	$2^5 - 2 = 30$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{19} - 2 = 524{,}286$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-11. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-11 *Question 4: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.100.18.18	0000 1010 0110 0**100 0001 00100001 0010**
Mask	255.248.0.0	1111 1111 1111 1**000 0000 0000 0000 0000**
AND result (subnet number)	10.96.0.0	0000 1010 0110 0**000 0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.103.255.255	0000 1010 0110 0**111 1111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.96.0.1 through 10.103.255.254

Table A-12 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-12 *Question 4: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4	Comments
Address	10	100	18	18	N/A
Mask	255	248	0	0	N/A
Subnet number	10	96	0	0	Magic number = 256 – 248 = 8
First address	10	96	0	1	Add 1 to last octet of subnet
Broadcast	10	103	255	255	96 + 8 – 1 = 103
Last address	10	103	255	254	Subtract 1 from last octet

Subnet rule: Multiple of magic number closest to, but not more than, IP address value in interesting octet
Broadcast rule: Subnet + magic – 1

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The second octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 248 = 8 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 96 is the multiple of 8 that's closest to 100 but not bigger than 100. So, the second octet of the subnet number is 96.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 96 + 8 – 1 = 103.

Question 5: Answer

Table A-13 *Question 5: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.150.200.200	N/A
Mask	255.252.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	18	Always defined as number of binary 0s in mask
Number of subnet bits	6	32 – (network size + host size)
Number of subnets	$2^6 - 2 = 62$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{18} - 2 = 262{,}142$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-14. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-14 *Question 5: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.150.200.200	0000 1010 1001 01**10 1100 1000 1100 1000**
Mask	255.252.0.0	1111 1111 1111 11**00 0000 0000 0000 0000**
AND result (subnet number)	10.148.0.0	0000 1010 0110 00**00 0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.151.255.255	0000 1010 0110 01**11 1111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.148.0.1 through 10.151.255.254

Table A-15 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-15 *Question 5: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4	Comments
Address	10	150	200	200	N/A
Mask	255	252	0	0	N/A
Subnet number	10	148	0	0	Magic number = 256 – 252 = 4
First address	10	148	0	1	Add 1 to last octet of subnet
Broadcast	10	151	255	255	148 + 4 – 1 = 151
Last address	10	151	255	254	Subtract 1 from last octet

Subnet rule: Multiple of magic number closest to, but not more than, IP address value in interesting octet
Broadcast rule: Subnet + magic – 1

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The second octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 252 = 4 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 148 is the multiple of 4 that's closest to 150 but not bigger than 150. So, the second octet of the subnet number is 148.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 148 + 4 – 1 = 151.

Question 6: Answer

Table A-16 *Question 6: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.150.200.200	N/A
Mask	255.254.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	17	Always defined as number of binary 0s in mask
Number of subnet bits	7	32 – (network size + host size)
Number of subnets	$2^7 - 2 = 126$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{17} - 2 = 131{,}070$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-17. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-17 *Question 6: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.150.200.200	0000 1010 1001 011**0 1100 1000 1100 1000**
Mask	255.254.0.0	1111 1111 1111 111**0 0000 0000 0000 0000**
AND result (subnet number)	10.150.0.0	0000 1010 0110 001**0 0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.151.255.255	0000 1010 0110 011**1 1111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.150.0.1 through 10.151.255.254

Table A-18 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-18 *Question 6: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	10	150	200	200
Mask	255	254	0	0
Subnet number	10	150	0	0
First valid address	10	150	0	1
Broadcast	10	151	255	255
Last valid address	10	151	255	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The second octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 254 = 2 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 150 is the multiple of 2 that's closest to 150 but not bigger than 150. So, the second octet of the subnet number is 150.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 150 + 2 – 1 = 151.

Question 7: Answer

Table A-19 *Question 7: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.220.100.18	N/A
Mask	255.255.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	16	Always defined as number of binary 0s in mask
Number of subnet bits	8	32 – (network size + host size)
Number of subnets	$2^8 - 2 = 254$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{16} - 2 = 65{,}534$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-20. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-20 *Question 7: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.220.100.18	0000 1010 1101 1100 **0110 0100 0001 0010**
Mask	255.255.0.0	1111 1111 1111 1111 **0000 0000 0000 0000**
AND result (subnet number)	10.220.0.0	0000 1010 1101 1100 **0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.220.255.255	0000 1010 1101 1100 **1111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.220.0.1 through 10.220.255.254

Table A-21 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4.

Table A-21 *Question 7: Subnet, Broadcast, First, and Last Addresses Calculated Using Subnet Chart*

	Octet 1	**Octet 2**	**Octet 3**	**Octet 4**
Address	10	220	100	18
Mask	255	255	0	0
Subnet number	10	220	0	0
First valid address	10	220	0	1
Broadcast	10	220	255	255
Last valid address	10	220	255	254

This subnetting scheme uses an easy mask because all of the octets are a 0 or a 255. No math tricks are needed at all!

Question 8: Answer

Table A-22 *Question 8: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.220.100.18	N/A
Mask	255.255.128.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	15	Always defined as number of binary 0s in mask
Number of subnet bits	9	32 – (network size + host size)
Number of subnets	$2^9 - 2 = 510$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{15} - 2 = 32{,}766$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-23. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-23 *Question 8: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.220.100.18	0000 1010 1101 1100 0**110 0100 0001 0010**
Mask	255.255.128.0	1111 1111 1111 1111 1**000 0000 0000 0000**
AND result (subnet number)	10.220.0.0	0000 1010 1101 1100 0**000 0000 0000 0000**
Change host to 1s (broadcast address)	10.220.127.255	0000 1010 1101 1100 0**111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.220.0.1 through 10.220.127.254

Table A-24 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-24 *Question 8: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	10	220	100	18
Mask	255	255	128	0
Subnet number	10	220	0	0
First address	10	220	0	1
Broadcast	10	220	127	255
Last Adress	10	220	127	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The third octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 128 = 128 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 0 is the multiple of 128 that's closest to 100 but not bigger than 100. So, the third octet of the subnet number is 0.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 0 + 128 – 1 = 127.

This example tends to confuse people because a mask with 128 in it gives you subnet numbers that just do not seem to look right. Table A-25 gives you the answers for the first several subnets, just to make sure that you are clear about the subnets when using this mask with a Class A network.

Table A-25 *Question 8: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Zero Subnet	First Valid Subnet	Second Valid Subnet	Third Valid Subnet
Subnet	10.0.0.0	10.0.128.0	10.1.0.0	10.1.128.0
First address	10.0.0.1	10.0.128.1	10.1.0.1	10.1.128.1
Last address	10.0.127.254	10.0.255.254	10.1.127.254	10.1.255.254
Broadcast	10.0.127.255	10.0.255.255	10.1.127.255	10.1.255.255

Question 9: Answer

Table A-26 *Question 9: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.31.100.100	N/A
Mask	255.255.192.0	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	14	Always defined as number of binary 0s in mask
Number of subnet bits	2	32 – (network size + host size)
Number of subnets	$2^2 - 2 = 2$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{14} - 2 = 16{,}382$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-27. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-27 *Question 9: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.31.100.100	1010 1100 0001 1111 01**10 0100 0110 0100**
Mask	255.255.192.0	1111 1111 1111 1111 11**00 0000 0000 0000**
AND result (subnet number)	172.31.64.0	1010 1100 0001 1111 01**00 0000 0000 0000**
Change host to 1s (broadcast address)	172.31.127.255	1010 1100 0001 1111 01**11 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.31.64.1 through 172.31.127.254

Table A-28 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-28 *Question 9: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	172	31	100	100
Mask	255	255	192	0
Subnet number	172	31	64	0
First valid address	172	31	64	1
Broadcast	172	31	127	255
Last valid address	172	31	127	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The third octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 192 = 64 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 64 is the multiple of 64 that's closest to 100 but not bigger than 100. So, the third octet of the subnet number is 64.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 64 + 64 – 1 = 127.

Question 10: Answer

Table A-29 *Question 10: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.31.100.100	N/A
Mask	255.255.224.0	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	13	Always defined as number of binary 0s in mask
Number of subnet bits	3	32 – (network size + host size)
Number of subnets	$2^3 - 2 = 6$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{13} - 2 = 8190$	$2^{\text{number-of-host-bits}} - 2$

The binary calculations of the subnet number and broadcast address are in Table A-30. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-30 *Question 10: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.31.100.100	1010 1100 0001 1111 011**0 0100 0110 0100**
Mask	255.255.224.0	1111 1111 1111 1111 111**0 0000 0000 0000**
AND result (subnet number)	172.31.96.0	1010 1100 0001 1111 011**0 0000 0000 0000**
Change host to 1s (broadcast address)	172.31.127.255	1010 1100 0001 1111 011**1 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.31.96.1 through 172.31.127.254

Table A-31 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-31 *Question 10: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	**Octet 2**	**Octet 3**	**Octet 4**
Address	172	31	100	100
Mask	255	255	224	0
Subnet number	172	31	96	0
First valid address	172	31	96	1
Broadcast	172	31	127	255
Last valid address	172	31	127	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The third octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 224 = 32 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet

(inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 96 is the multiple of 32 that's closest to 100 but not bigger than 100. So, the third octet of the subnet number is 96.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 96 + 32 – 1 = 127.

Question 11: Answer

Table A-32 *Question 11: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.31.200.10	N/A
Mask	255.255.240.0	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	12	Always defined as number of binary 0s in mask
Number of subnet bits	4	32 – (network size + host size)
Number of subnets	$2^4 - 2 = 14$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{12} - 2 = 4094$	$2^{\text{number-of-host-bits}} - 2$

Table A-33 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-33 *Question 11: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.31.200.10	1010 1100 0001 1111 1100 **1000 0000 1010**
Mask	255.255.240.0	1111 1111 1111 1111 1111 **0000 0000 0000**
AND result (subnet number)	172.31.192.0	1010 1100 0001 1111 1100 **0000 0000 0000**
Change host to 1s (broadcast address)	172.31.207.255	1010 1100 0001 1111 1100 **1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.31.192.1 through 172.31.207.254

Table A-34 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-34 *Question 13: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	172	31	200	10
Mask	255	255	240	0
Subnet number	172	31	192	0
First valid address	172	31	192	1
Broadcast	172	31	207	255
Last valid address	172	31	207	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The third octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 240 = 16 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 192 is the multiple of 16 that's closest to 200 but not bigger than 200. So, the third octet of the subnet number is 192.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 192 + 16 – 1 = 207.

Question 12: Answer

Table A-35 *Question 12: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.31.200.10	N/A
Mask	255.255.248.0	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	11	Always defined as number of binary 0s in mask
Number of subnet bits	5	32 – (network size + host size)
Number of subnets	$2^5 - 2 = 30$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{11} - 2 = 2046$	$2^{\text{number-of-host-bits}} - 2$

Table A-36 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-36 *Question 12: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.31.200.10	1010 1100 0001 1111 1100 1**000 0000 1010**
Mask	255.255.248.0	1111 1111 1111 1111 1111 1**000 0000 0000**
AND result (subnet number)	172.31.200.0	1010 1100 0001 1111 1100 1**000 0000 0000**
Change host to 1s (broadcast address)	172.31.207.255	1010 1100 0001 1111 1100 1**111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.31.200.1 through 172.31.207.254

Table A-37 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-37 *Question 12: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	172	31	200	10
Mask	255	255	248	0
Subnet number	172	31	200	0
First valid address	172	31	200	1
Broadcast	172	31	207	255
Last valid address	172	31	207	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The third octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 248 = 8 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 200 is the multiple of 8 that's closest to 200 but not bigger than 200. So, the third octet of the subnet number is 200.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 200 + 8 – 1 = 207.

Question 13: Answer

Table A-38 *Question 13: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.31.50.50	N/A
Mask	255.255.252.0	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	10	Always defined as number of binary 0s in mask
Number of subnet bits	6	32 – (network size + host size)
Number of subnets	$2^6 - 2 = 62$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{10} - 2 = 1022$	$2^{\text{number-of-host-bits}} - 2$

Table A-39 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-39 *Question 13: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.31.50.50	1010 1100 0001 1111 0011 00**10 0011 0010**
Mask	255.255.252.0	1111 1111 1111 1111 1111 11**00 0000 0000**
AND result (subnet number)	172.31.48.0	1010 1100 0001 1111 0011 00**00 0000 0000**
Change host to 1s (broadcast address)	172.31.51.255	1010 1100 0001 1111 0011 00**11 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.31.48.1 through 172.31.51.254

Table A-40 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-40 *Question 13: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	**Octet 2**	**Octet 3**	**Octet 4**
Address	172	31	50	50
Mask	255	255	252	0
Subnet number	172	31	48	0
First valid address	172	31	48	1
Broadcast	172	31	51	255
Last valid address	172	31	51	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The third octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 252 = 4 in this case (256 –

mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 48 is the multiple of 4 that's closest to 50 but not bigger than 50. So, the third octet of the subnet number is 48.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 48 + 4 – 1 = 51.

Question 14: Answer

Table A-41 *Question 14: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.31.50.50	N/A
Mask	255.255.254.0	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	9	Always defined as number of binary 0s in mask
Number of subnet bits	7	32 – (network size + host size)
Number of subnets	$2^7 - 2 = 126$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^9 - 2 = 510$	$2^{\text{number-of-host-bits}} - 2$

Table A-42 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-42 *Question 14: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.31.50.50	1010 1100 0001 1111 0011 001**0 0011 0010**
Mask	255.255.254.0	1111 1111 1111 1111 1111 111**0 0000 0000**
AND result (subnet number)	172.31.50.0	1010 1100 0001 1111 0011 001**0 0000 0000**
Change host to 1s (broadcast address)	172.31.51.255	1010 1100 0001 1111 0011 001**1 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.31.50.1 through 172.31.51.254

Table A-43 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-43 *Question 14: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	172	31	50	50
Mask	255	255	254	0
Subnet number	172	31	50	0
First valid address	172	31	50	1
Broadcast	172	31	51	255
Last valid address	172	31	51	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The third octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 254 = 2 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 50 is the multiple of 2 that's closest to 50 but not bigger than 50. So, the third octet of the subnet number is 50.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 50 + 2 – 1 = 51.

Question 15: Answer

Table A-44 *Question 15: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.31.140.14	N/A
Mask	255.255.255.0	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	8	Always defined as number of binary 0s in mask
Number of subnet bits	8	32 – (network size + host size)
Number of subnets	$2^8 - 2 = 254$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^8 - 2 = 254$	$2^{\text{number-of-host-bits}} - 2$

Table A-45 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-45 *Question 15: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.31.140.14	1010 1100 0001 1111 1000 1100 **0000 1110**
Mask	255.255.255.0	1111 1111 1111 1111 1111 1111 **0000 0000**
AND result (subnet number)	172.31.140.0	1010 1100 0001 1111 1000 1100 **0000 0000**
Change host to 1s (broadcast address)	172.31.140.255	1010 1100 0001 1111 1000 1100 **1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.31.140.1 through 172.31.140.254

Table A-46 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4.

Table A-46 *Question 15: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	172	31	140	14
Mask	255	255	255	0
Subnet number	172	31	140	0
First valid address	172	31	140	1
Broadcast	172	31	140	255
Last valid address	172	31	140	254

This subnetting scheme uses an easy mask because all of the octets are a 0 or a 255. No math tricks are needed at all!

Question 16: Answer

Table A-47 *Question 16: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.31.140.14	N/A
Mask	255.255.255.128	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	7	Always defined as number of binary 0s in mask
Number of subnet bits	9	32 – (network size + host size)
Number of subnets	$2^9 - 2 = 510$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^7 - 2 = 126$	$2^{\text{number-of-host-bits}} - 2$

Table A-48 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-48 *Question 16: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.31.140.14	1010 1100 0001 1111 1000 1100 0**000 1110**
Mask	255.255.255.128	1111 1111 1111 1111 1111 1111 1**000 0000**
AND result (subnet number)	172.31.140.0	1010 1100 0001 1111 1000 1100 0**000 0000**
Change host to 1s (broadcast address)	172.31.140.127	1010 1100 0001 1111 1000 1100 0**111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.31.140.1 through 172.31.140.126

Table A-49 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-49 *Question 16: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	**Octet 2**	**Octet 3**	**Octet 4**
Address	172	31	140	**14**
Mask	*255*	*255*	*255*	**128**
Subnet number	172	31	140	**0**
First valid address	172	31	140	**1**
Broadcast	172	31	140	**127**
Last valid address	172	31	140	**126**

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The fourth octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 128 = 128 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 0 is the multiple of 128 that's closest to 14 but not bigger than 14. So, the fourth octet of the subnet number is 0.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet.

Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 0 + 128 – 1 = 127.

Question 17: Answer

Table A-50 *Question 17: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	192.168.15.150	N/A
Mask	255.255.255.192	N/A
Number of network bits	24	Always defined by Class A, B, C
Number of host bits	6	Always defined as number of binary 0s in mask
Number of subnet bits	2	32 – (network size + host size)
Number of subnets	$2^2 - 2 = 2$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^6 - 2 = 62$	$2^{\text{number-of-host-bits}} - 2$

Table A-51 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-51 *Question 17: Binary Calculation of Subnet and Broadcast Addresses*

Address	192.168.15.150	1100 0000 1010 1000 0000 1111 10**01 0110**
Mask	255.255.255.192	1111 1111 1111 1111 1111 1111 11**00 0000**
AND result (subnet number)	192.168.15.128	1100 0000 1010 1000 0000 1111 10**00 0000**
Change host to 1s (broadcast address)	192.168.15.191	1100 0000 1010 1000 0000 1111 10**11 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

192.168.15.129 through 192.168.15.190

Table A-52 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-52 *Question 17: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	192	168	15	150
Mask	255	255	255	192
Subnet number	192	168	15	128
First valid address	192	168	15	129
Broadcast	192	168	15	191
Last valid address	192	168	15	190

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The fourth octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 192 = 64 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 128 is the multiple of 64 that's closest to 150 but not bigger than 150. So, the fourth octet of the subnet number is 128.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 128 + 64 – 1 = 191.

Question 18: Answer

Table A-53 *Question 18: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	192.168.15.150	N/A
Mask	255.255.255.224	N/A
Number of network bits	24	Always defined by Class A, B, C
Number of host bits	5	Always defined as number of binary 0s in mask
Number of subnet bits	3	32 – (network size + host size)
Number of subnets	$2^3 - 2 = 6$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^5 - 2 = 30$	$2^{\text{number-of-host-bits}} - 2$

Table A-54 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-54 *Question 18: Binary Calculation of Subnet and Broadcast Addresses*

Address	192.168.15.150	1100 0000 1010 1000 0000 1111 100**1 0110**
Mask	255.255.255.224	1111 1111 1111 1111 1111 1111 111**0 0000**
AND result (subnet number)	192.168.15.128	1100 0000 1010 1000 0000 1111 100**0 0000**
Change host to 1s (broadcast address)	192.168.15.159	1100 0000 1010 1000 0000 1111 100**1 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

192.168.15.129 through 192.168.15.158

Table A-55 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value

from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-55 *Question 18: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	192	168	15	150
Mask	255	255	255	224
Subnet number	192	168	15	128
First valid address	192	168	15	129
Broadcast	192	168	15	159
Last valid address	192	168	15	158

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The fourth octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 224 = 32 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 128 is the multiple of 32 that's closest to 150 but not bigger than 150. So, the fourth octet of the subnet number is 128.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 128 + 32 – 1 = 159.

Question 19: Answer

Table A-56 *Question 19: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	192.168.100.100	N/A
Mask	255.255.255.240	N/A
Number of network bits	24	Always defined by Class A, B, C
Number of host bits	4	Always defined as number of binary 0s in mask
Number of subnet bits	4	32 – (network size + host size)
Number of subnets	$2^4 - 2 = 14$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^4 - 2 = 14$	$2^{\text{number-of-host-bits}} - 2$

Table A-57 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-57 *Question 19: Binary Calculation of Subnet and Broadcast Addresses*

Address	192.168.100.100	1100 0000 1010 1000 0110 0100 0110 **0100**
Mask	255.255.255.240	1111 1111 1111 1111 1111 1111 1111 **0000**
AND result (subnet number)	192.168.100.96	1100 0000 1010 1000 0110 0100 0110 **0000**
Change host to 1s (broadcast address)	192.168.100.111	1100 0000 1010 1000 0110 0100 0110 **1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

192.168.100.97 through 192.168.100.110

Table A-58 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value

from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-58 *Question 19: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	192	168	100	100
Mask	255	255	255	240
Subnet number	192	168	100	96
First valid address	192	168	100	97
Broadcast	192	168	100	111
Last valid address	192	168	100	110

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The fourth octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 240 = 16 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 96 is the multiple of 16 that's closest to 100 but not bigger than 100. So, the fourth octet of the subnet number is 96.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 96 + 16 – 1 = 111.

Question 20: Answer

Table A-59 *Question 20: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	192.168.100.100	N/A
Mask	255.255.255.248	N/A
Number of network bits	24	Always defined by Class A, B, C
Number of host bits	3	Always defined as number of binary 0s in mask
Number of subnet bits	5	32 – (network size + host size)
Number of subnets	$2^5 - 2 = 30$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^3 - 2 = 6$	$2^{\text{number-of-host-bits}} - 2$

Table A-60 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-60 *Question 20: Binary Calculation of Subnet and Broadcast Addresses*

Address	192.168.100.100	1100 0000 1010 1000 0110 0100 0110 0**100**
Mask	255.255.255.248	1111 1111 1111 1111 1111 1111 1111 1**000**
AND result (subnet number)	192.168.100.96	1100 0000 1010 1000 0110 0100 0110 0**000**
Change host to 1s (broadcast address)	192.168.100.103	1100 0000 1010 1000 0110 0100 0110 0**111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

192.168.100.97 through 192.168.100.102

Table A-61 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value

from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-61 *Question 20: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	192	168	100	100
Mask	255	255	255	248
Subnet number	192	168	100	96
First valid address	192	168	100	97
Broadcast	192	168	100	103
Last valid address	192	168	100	102

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The fourth octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 248 = 8 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 96 is the multiple of 8 that's closest to 100 but not bigger than 100. So, the fourth octet of the subnet number is 96.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 96 + 8 – 1 = 103.

Question 21: Answer

Table A-62 *Question 21: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	192.168.15.230	N/A
Mask	255.255.255.252	N/A
Number of network bits	24	Always defined by Class A, B, C
Number of host bits	2	Always defined as number of binary 0s in mask
Number of subnet bits	6	32 – (network size + host size)
Number of subnets	$2^6 - 2 = 62$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^2 - 2 = 2$	$2^{\text{number-of-host-bits}} - 2$

Table A-63 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-63 *Question 21: Binary Calculation of Subnet and Broadcast Addresses*

Address	192.168.15.230	1100 0000 1010 1000 0000 1111 1110 01**10**
Mask	255.255.255.252	1111 1111 1111 1111 1111 1111 1111 11**00**
AND result (subnet number)	192.168.15.228	1100 0000 1010 1000 0000 1111 1110 01**00**
Change host to 1s (broadcast address)	192.168.15.231	1100 0000 1010 1000 0000 1111 1110 01**11**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

192.168.15.229 through 192.168.15.230

Table A-64 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-64 *Question 21: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	192	168	15	230
Mask	255	255	255	252
Subnet number	192	168	15	228
First valid address	192	168	15	229
Broadcast	192	168	15	231
Last valid address	192	168	15	230

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The fourth octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 252 = 4 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 228 is the multiple of 4 that's closest to 230 but not bigger than 230. So, the fourth octet of the subnet number is 228.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 228 + 4 – 1 = 231.

Question 22: Answer

Table A-65 *Question 22: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.1.1.1	N/A
Mask	255.248.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	19	Always defined as number of binary 0s in mask
Number of subnet bits	5	32 – (network size + host size)
Number of subnets	$2^5 - 2 = 30$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{19} - 2 = 524{,}286$	$2^{\text{number-of-host-bits}} - 2$

Table A-66 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-66 *Question 22: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.1.1.1	0000 1010 0000 0**001 0000 0001 0000 0001**
Mask	255.248.0.0	1111 1111 1111 1**000 0000 0000 0000 0000**
AND result (subnet number)	10.0.0.0	0000 1010 0000 0**000 0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.7.255.255	0000 1010 0000 0**111 1111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.0.0.1 through 10.7.255.254

Take a closer look at the subnet part of the subnet address, as is shown in bold here: 0000 1010 **0000 0**000 0000 0000 0000 0000. The subnet part of the address is all binary 0s, making this subnet a zero subnet. This subnet should be avoided unless you are running out of available subnets to use.

Table A-67 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-67 *Question 22: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	10	1	1	1
Mask	255	248	0	0
Subnet number	10	0	0	0
First valid address	10	0	0	1
Broadcast	10	7	255	255
Last valid address	10	7	255	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The second octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 248 = 8 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 0 is the multiple of 8 that's closest to 1 but not bigger than 1. So, the second octet of the subnet number is 0.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 0 + 8 – 1 = 7.

Question 23: Answer

Table A-68 *Question 23: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.16.1.200	N/A
Mask	255.255.240.0	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	12	Always defined as number of binary 0s in mask
Number of subnet bits	4	32 – (network size + host size)
Number of subnets	$2^4 - 2 = 14$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{12} - 2 = 4094$	$2^{\text{number-of-host-bits}} - 2$

Table A-69 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-69 *Question 23: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.16.1.200	1010 1100 0001 0000 0000 **0001 1100 1000**
Mask	255.255.240.0	1111 1111 1111 1111 1111 **0000 0000 0000**
AND result (subnet number)	172.16.0.0	1010 1100 0001 0000 0000 **0000 0000 0000**
Change host to 1s (broadcast address)	172.16.15.255	1010 1100 0001 0000 0000 **1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.16.0.1 through 172.16.15.254

Take a closer look at the subnet part of the subnet address, as shown in bold here: 1010 1100 0001 0000 **0000** 0000 0000 0000. The subnet part of the address is all binary 0s, making this subnet a zero subnet. This subnet should be avoided unless you are running out of available subnets to use.

Table A-70 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-70 *Question 23: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	172	16	1	200
Mask	255	255	240	0
Subnet number	172	16	0	0
First valid address	172	16	0	1
Broadcast	172	16	15	255
Last valid address	172	16	15	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The third octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 240 = 16 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 0 is the multiple of 16 that's closest to 1 but not bigger than 1. So, the third octet of the subnet number is 0.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 0 + 16 – 1 = 15.

Question 24: Answer

Table A-71 *Question 24: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	172.16.0.200	N/A
Mask	255.255.255.192	N/A
Number of network bits	16	Always defined by Class A, B, C
Number of host bits	6	Always defined as number of binary 0s in mask
Number of subnet bits	10	32 – (network size + host size)
Number of subnets	$2^{10} - 2 = 1022$	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{6} - 2 = 62$	$2^{\text{number-of-host-bits}} - 2$

Table A-72 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-72 *Question 24: Binary Calculation of Subnet and Broadcast Addresses*

Address	172.16.0.200	1010 1100 0001 0000 0000 0000 11**00 1000**
Mask	255.255.255.192	1111 1111 1111 1111 1111 1111 11**00 0000**
AND result (subnet number)	172.16.0.192	1010 1100 0001 0000 0000 0000 11**00 0000**
Change host to 1s (broadcast address)	172.16.0.255	1010 1100 0001 0000 0000 0000 11**11 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

172.16.0.193 through 172.16.0.254

Table A-73 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4. Remember, subtracting the interesting (non-0 or 255) mask value from 256 yields the magic number. The magic number multiple that's closest to but not larger than the IP address's interesting octet value is the subnet value in that octet.

Table A-73 *Question 24: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	172	16	0	200
Mask	255	255	255	192
Subnet number	172	16	0	192
First valid address	172	16	0	193
Broadcast	172	16	0	255
Last valid address	172	16	0	254

This subnetting scheme uses a hard mask because one of the octets is not a 0 or a 255. The fourth octet is "interesting" in this case. The key part of the trick to get the right answers is to calculate the magic number, which is 256 – 192 = 64 in this case (256 – mask's value in the interesting octet). The subnet number's value in the interesting octet (inside the box) is the multiple of the magic number that's not bigger than the original IP address's value in the interesting octet. In this case, 192 is the multiple of 64 that's closest to 200 but not bigger than 200. So, the fourth octet of the subnet number is 192.

The second tricky part of this process calculates the subnet broadcast address. The full process is described in Chapter 4, but the tricky part is, as usual, in the "interesting" octet. Take the subnet number's value in the interesting octet, add the magic number, and subtract 1. That's the broadcast address's value in the interesting octet. In this case, 192 + 64 – 1 = 255.

You can easily forget that the subnet part of this address, when using this mask, actually covers all of the third octet as well as 2 bits of the fourth octet. For instance, the valid subnet numbers in order are listed here, starting with the first valid subnet by avoiding subnet 172.16.0.0–the zero subnet in this case:

172.16.0.64
172.16.0.128
172.16.0.192
172.16.1.0
172.16.1.64
172.16.1.128
172.16.1.192
172.16.2.0
172.16.2.64
172.16.2.128
172.16.2.192
172.16.3.0
172.16.3.64
172.16.3.128
172.16.3.192

And so on.

Question 25: Answer

Congratulations, you made it through all the extra subnetting practice! Here's an easy one to complete your review—one with no subnetting at all!

Table A-74 *Question 25: Size of Network, Subnet, Host, Number of Subnets, Number of Hosts*

Step	Example	Rules to Remember
Address	10.1.1.1	N/A
Mask	255.0.0.0	N/A
Number of network bits	8	Always defined by Class A, B, C
Number of host bits	24	Always defined as number of binary 0s in mask
Number of subnet bits	0	32 – (network size + host size)
Number of subnets	0	$2^{\text{number-of-subnet-bits}} - 2$
Number of hosts	$2^{24} - 2 =$ 16,777,214	$2^{\text{number-of-host-bits}} - 2$

Table A-75 shows the binary calculations of the subnet number and broadcast address. To calculate the subnet number, perform a Boolean AND of the address with the subnet mask. To find the broadcast address for this subnet, change all the host bits to binary 1s in the subnet number. The host bits are in **bold** print in the table.

Table A-75 *Question 25: Binary Calculation of Subnet and Broadcast Addresses*

Address	10.1.1.1	0000 1010 **0000 0001 0000 0001 0000 0001**
Mask	255.0.0.0	1111 1111 **0000 0000 0000 0000 0000 0000**
AND result (subnet number)	10.0.0.0	0000 1010 **0000 0000 0000 0000 0000 0000**
Change host to 1s (broadcast address)	10.255.255.255	0000 1010 **1111 1111 1111 1111 1111 1111**

Just add 1 to the subnet number to get the first valid IP address; just subtract 1 from the broadcast address to get the last valid IP address. In this case:

10.0.0.1 through 10.255.255.254

Table A-76 lists the way to get the same answers using the subnet chart and magic math described in Chapter 4.

Table A-76 *Question 25: Subnet, Broadcast, First and Last Addresses Calculated Using Subnet Chart*

	Octet 1	Octet 2	Octet 3	Octet 4
Address	10	1	1	1
Mask	255	0	0	0
Network number	10	0	0	0
First valid address	10	0	0	1
Broadcast	10	255	255	255
Last valid address	10	255	255	254